THE CLASSIFICATION OF THE NIAGARAN FORMATIONS OF WESTERN OHIO[1]

CHARLES S. PROSSER
Ohio State University

CONTENTS

INTRODUCTION
DESCRIPTION OF SECTIONS
Ludlow Creek Sections
Section of Ludlow Falls and the Smith Quarry
Section of Western Wall of the Smith Quarry
Section of the Otto Ehlers Quarry
Section of the Maxwell Quarry
General Section along Ludlow Creek
Correlation of the Brassfield Limestone
Other Sections of Western Ohio
Sections in and near Covington
Section of the Jackson Stone Co. Quarry
Section of the J. W. Ruhl Quarry at Covington
Section near Lewisburg
Section at the Lewisburg Stone Co. Quarry
Section near Laurel, Indiana
Derbyshire Falls Section

INTRODUCTION

There has been more or less uncertainty concerning the names which ought to be used for the Niagaran formations of the Silurian system in western Ohio together with their correlation with the formations of the same series in eastern Indiana. Field work in the summer of 1914 in this area has cleared up some of this uncertainty and part of the results are deemed of sufficient importance to warrant their early publication.

[1] Presented at the Ohio Academy of Science meeting in Columbus on November 28, 1914, and at the American Association for the Advancement of Science meeting in Columbus on December 28, 1915. Published by permission of the State Geologist of Ohio.

A series of sections at Piqua, along the Stillwater River between Covington and West Milton, and along Ludlow Creek in Miami County, and in the vicinity of Lewisburg, Eaton, and New Paris in Preble County, has furnished the writer the complete section from the Ordovician to the highest Silurian rocks of this area.

DESCRIPTION OF SECTIONS

The contact of the Ordovician and Silurian systems is clearly shown at Ludlow Falls, and the succeeding rocks as high as they extend in this region are admirably exposed at the falls and in the series of quarries which border the creek for some distance above the falls. Sections at other localities agree with the ones along this creek and show that the general order of succession is essentially the same for these counties.

LUDLOW CREEK SECTIONS

Four of the series of sections measured along Ludlow Creek will be given, which were checked by several other sections along the same stream. From these a general section of the rocks shown along this creek can be compiled.

The following section is based on the outcrops in the northeastern corner of the Colonel Samuel B. Smith quarry and the bank at the northern end of Ludlow Falls:

SECTION OF LUDLOW FALLS AND THE SMITH QUARRY

No.		Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
6.	*Dayton limestone.*—Northeast corner of the Colonel Samuel B. Smith quarry. The rock varies from light gray to somewhat darker gray on fresh fracture and some as weathered is bluish-gray. Other layers on the weathered faces are buff to brownish or rusty color from disintegrated iron pyrite. The rock splits into even-bedded layers; but the surfaces of the bedding planes are frequently rather rough and show stylolites structure. The majority of the layers vary in thickness from 2 to 10 inches, most of them ranging from 4 to 6 inches. The lowest layer is from 3 to 4 inches thick, and the				

No.	Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
next one above 10 inches, which in places splits into 2 layers with hackletooth structure at contact. The lower layers contain iron pyrite, which stains them on weathering. There are also calcite crystals, but no fossils were noted	8	2	41	5
5. *Brassfield limestone.*—Crystalline and crinoidal light-gray to pinkish limestone, with very irregular bedding planes. Specimens of corals and Stromatopora are rather common, and there is an occasional Brachiopod shell. In places there are irregular masses of blue shale which contain a good many corals. This is the bottom of the quarry at this corner, and the barometer with an interval of only 7 minutes read the same at the highest outcrop of the Brassfield limestone on the northern bank of Ludlow Creek, just above the Dayton, Covington, and Piqua traction bridge and Ludlow Falls.....	5	1	33	3
4. The upper 5 feet of the bank at the northern end of Ludlow Falls varies in color from light gray to pinkish and greenish, while some of it when weathered is brownish. Most of it is coarsely crystalline, part of it is very crinoidal, and it contains large numbers of Bryozoa, corals, and Stromatopora.....	5	0	28	2
3. Rather massive, more or less crystalline, limestone, which is of light-gray color, somewhat brownish as weathered; and some of it is very light gray, almost white, and is locally called a "marble." It contains very few fossils, if any. At the center of the falls there are 11 feet of the Brassfield limestone undercut by the water of the stream.....	16	6	23	2
2. *Belfast bed.*[1]—Blue rock, which is probably argillaceous and rather sandy, with layers from 2 to 6 inches thick and the average about 3 inches. This zone was thought by Dr. Foerste				

[1] The writer understands Dr. Foerste to now refer the Belfast bed to the Richmond, which is also the opinion of Dr. E. R. Cumings, based on a study of its Bryozoa. Dr. W. H. Shideler, however, has found certain Brachiopods in the Belfast which he thinks allies it with the Brassfield.

No.	Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
to represent the Belfast, since he wrote, "If they [the layers] represent the Belfast bed of more eastern sections, as is believed to be the case, they certainly have changed considerably from the typical form of the rock."[1]	2	8	6	8
1. *Richmond formation.*—Rather thin-bedded blue rock to shaly layers, perhaps with sandy to calcareous composition. This zone extends to water level and blue shale is washed out of a pit that has been dug still deeper by the water. About 5 feet of this zone are shown in the bank on the southern side	4	0	4	0

The foregoing section gives 26 feet 7 inches for the thickness of the Brassfield limestone. This agrees fairly well with the estimate based upon the thickness of the Brassfield on the northern bank at the falls and the section in the Big Four Railway cut west of the station on the southern side of the creek. Mr. W. Z. Miller, my assistant, made the top of the Brassfield limestone in the railway cut about 7 feet higher than the top of the ledge on the northern bank of the creek, which gave 28½ feet for the total thickness of the Brassfield limestone on Ludlow Creek.

The general section of Ludlow Creek is continued by the section of the western wall of the Colonel Samuel B. Smith quarry and the bank above it, below the house of Patrick Gallagher.

SECTION OF WESTERN WALL OF THE SMITH QUARRY

No.	Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
26. *Laurel limestone.*—Top of bank just below house of Mr. Patrick Gallagher. Light- to bluish-gray rock in fairly even layers varying from 2 to 5 inches in thickness. The upper weathered ones are rather buff and finely porous	3	5	24	10
25. Partly covered interval. Light- to brownish-gray, rather thin-bedded, dolomite	2	8	21	5
24. *Osgood beds.*—Partly covered zone; but at top bluish-gray shale to shaly limestone	1	3	18	9

[1] *Journal of the Cincinnati Society of Natural History*, XVIII (1896), 182.

No.	Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
23. Brownish- to bluish-gray, thin layer, from 1 to 2 inches thick		1½±	17	6
22. Bluish-gray shaly limestone to shale, from 6 to 7 inches thick. A specimen of *Leptaena rhomboidalis* (Wilckens) was noted		6½±	17	4½
21. *Dayton limestone.*—Top layer of western bank of the Colonel Samuel B. Smith quarry. Light gray, with rusty spots due to iron pyrite, from 3 to 4 inches thick		3½±	16	10
20. Layer 2± inches thick		2 ±	16	6½
19. Layer from 3 to 4 inches thick with dark-gray blotches in its upper part		3½±	16	4½
18. Dark-gray irregular bands in the lighter colored rock. It contains iron pyrite and varies from 4 to 5 inches in thickness		4½±	16	1
17. Light-gray rock without much dark color, which contains some iron pyrite and varies from 5 to 6 inches in thickness		5½±	15	8½
16. Three-inch layer at bottom of more or less massive zone (Nos. 16 to 21, inclusive), with average thickness of 1 foot 10 inches at top of quarry wall on the western and northern sides		3	15	3
15. Two rather compact layers, the upper one 4 inches and the lower, 6 inches thick		10	15	0
14. This layer will split up into thinner ones and it contains iron pyrite		9	14	2
13. Compact layer		4	13	5
12. This layer may split up to some extent on weathering		9	13	1
11. This layer on weathering splits into various layers from 2 to 5 inches thick	1	2	12	4
10. This layer on weathering tends to split into layers from 2½ to 4 inches thick		9	11	2
9. Layer with dark-gray blotches or banding due to iron pyrite		6	10	5
8. Layer from 5 to 6 inches thick, which tends to split to some extent and contains masses of calcite		5½±	9	11
7. Six-inch layer with stylolites structure in the basal portion		6	9	5½
6. The limestone of this layer and the underlying Dayton layers is, in general, compact, probably				

No.		Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
	somewhat impure, and in part of rather light-gray color. This layer varies in thickness from 12 to 13 inches	1	½ ±	8	11½
5.	Eleven-inch layer		11	7	11
4.	Four-inch layer		4	7	0
3.	Layer from 7 to 8 inches thick		7½ ±	6	8
2.	Layer from 3 to 4 inches thick and the base of the Dayton limestone. The average thickness of layers Nos. 2 to 15, inclusive, is 9 feet 3 inches The Dayton limestone is correlated by the writer with the compact, even-bedded limestone below the soft, blue shale or clay of the Osgood beds of Indiana, as defined by Dr. Foerste. Therefore in this and the following sections of this paper the Dayton limestone is regarded as the lower member of the Osgood beds.		3½ ±	6	½
1.	*Brassfield limestone.*—The bottom layer of the extreme western wall of this quarry is the upper part of the Brassfield limestone. Farther to the southeast on this western side of the quarry 5¾ feet of the upper Brassfield limestone, from its contact with the Dayton limestone to the bottom of the quarry, is shown. It is a crystalline limestone of light-gray to pinkish color, the bedding surfaces frequently of greenish color. The upper part is fairly fossiliferous, the common forms being corals, Bryozoa, Stromatopora, and crinoid segments. Some of the rock contains so many crinoid segments that it is a crinoidal limestone. Bottom of this part of the quarry	5	9	5	9

In the foregoing section, Nos. 2 to 21, inclusive, are referred to the Dayton limestone, which then has an average thickness of 11 feet 1 inch in the western part of the Smith quarry. Samples of the Dayton limestone from this quarry were analyzed by Professor D. J. Demorest with the following result:

Siliceous Residue	Fe_2O_3 and Al_2O_3	$CaCO_3$	$MgCO_3$
9.97	1.35	55.37	31.18
10.10	1.40	55.37	31.23

Nos. 2 to 24, inclusive, are referred to the Osgood beds, which gives this formation in this section an average thickness of 13 feet.

Farther west in the series of quarries on the northern side of Ludlow Creek is the one of Otto Ehlers, which in the Miami County report is called the Ellis quarry.[1] The section of this quarry is important in determining the stratigraphy of this region due to the excellent exposure of the shale zone (No. 7 of section) which separates the Dayton and Laurel limestones.

SECTION OF THE OTTO EHLERS QUARRY

No.		Thickness Fee	Thickness Inches	Total Thickness Feet	Total Thickness Inches
21.	*Laurel limestone.*—Three layers at the top of the quarry wall which in descending order are respectively 4, 7, and 6 inches thick. As weathered, these layers are buff-colored and fairly compact. The upper part of this zone is perhaps above the Laurel limestone	1	5	20	4
20.	Compact layer which is more massive than the two immediately below it		10	18	11
19.	More compact layer than that immediately underlying it		8	18	1
18.	It splits into 2 or more layers which are similar to underlying ones		6	17	5
17.	Compact, light-gray dolomite, weathering to buff color and varying from 6 to 7 inches in thickness		6½ ±	16	11
16.	It tends to split at the bottom into 3 layers		6	16	4½
15.	Light-gray dolomite which weathers to buff color		3	15	10½
14.	Shale containing calcareous nodules to shaly limestone		3	15	7½
13.	Light-gray, weathering to buff color, compact dolomite		10	15	4½
12.	Shaly, light-gray dolomite, weathering to buff color, from 3 to 5 inches thick		4 ±	14	6½
11.	Light-gray, argillaceous shale		2	14	2½
10.	Light-gray, fine-grained dolomite, which splits into 3 layers	1	8	14	½
9.	Light-gray, argillaceous shale		3	12	4½

[1] *Report of the Geological Survey of Ohio*, III (1878), 479.

No.	Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
8. Zone of rather thin layers of light-gray to bluish-gray dolomite, with shaly to shale partings	1	4	12	1½
7. *Osgood beds.*—Zone of rather dark-gray shale which weathers to a bluish-gray color and is rather calcareous. Conspicuous zone on quarry wall	3	2	10	9½
6. *Dayton limestone.*—Massive zone at top of Dayton limestone which splits into at least 3 layers, which, in descending order, are respectively 9 to 10, 3, and 11 to 12 inches thick. It is a light- to bluish-gray, compact limestone	2±	0	7	7½
5. Light- to bluish-gray limestone forming massive zone on northern wall. It splits, however, into 3 layers, which, in descending order, are respectively 11, 7, and 8 inches thick	2	2	5	7½
4. Light-gray layer on weathered face from 12 to 14 inches thick, which will split into 2 or 3 layers	1	1 ±	3	5½
3. Layer similar to those below it		10	2	4½
2. Bluish-gray, compact layer, 7 to 8 inches thick		7½ ±	1	6½
1. Bluish-gray, compact rock, containing large masses of calcite. Bottom of exposed rock in quarry		11		11

In the foregoing section the shale zone (No. 7) which separates the Dayton limestone from the Laurel limestone is beautifully shown on the quarry wall. This layer of shale was recognized in various sections in Miami and Preble counties and is a very important aid in identifying the formations of these counties and correlating them with those of southeastern Indiana.

At the western end of the almost continuous line of quarries on the northern side of Ludlow Creek is the Maxwell quarry, the upper part of which carries the general section along Ludlow Creek stratigraphically higher than those already described. The following section of this quarry was measured at its western end to the west of the J. J. Wagner brick house:

SECTION OF THE MAXWELL QUARRY

No.	Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
19. *Springfield dolomite.*—Light gray, weathering to whitish color on surface, and splitting into layers varying from 2 to 6 inches. Impression of *Calymene niagarensis* Hall about 1 foot below the top of this zone	2	6	25	8
18. Light-gray layer with *Pentamerus oblongus* Sowerby common in its lower 3 inches		5	23	2
17. *Mottled zone.*—Massive zone of mottled-colored dolomite, gray with light-colored blotches and spots, which splits into 2 conspicuous layers on part of the quarry wall and more where much weathered. Surface rather rough and pitted when weathered. This zone has been correlated with the West Union limestone; but there is some uncertainty whether that limestone extends as far to the northwest as this locality and consequently for the present it is not referred to any definite formation	5	6	22	9
16. *Laurel limestone.*—Thin-bedded with uneven bedding planes. As weathered, rusty to brownish color on surface, which extends for some distance into the rock	1	10	17	3
15. Light-gray to bluish-gray, compact layer		5	15	5
14. Thin-bedded, light- to bluish-gray zone, with irregular bedding planes		10	15	0
13. Compact, light- to bluish-gray layer		5	14	2
12. Rather shaly layer		5	13	9
11. Two compact, light-gray layers, the upper 9 and the lower 8 inches thick	1	5	13	4
10. Light-gray, shaly dolomite and blue shale		6	11	11
9. Thin-bedded dolomite splitting into 3 or 4 layers	1	4	11	5
8. *Osgood beds.*—Fine blue, argillaceous shale to clay	1	8	10	1
7. Rather coarse, blocky blue shale which forms the lower part of the shale zone. Nos. 7 and 8 constitute the shale zone in the upper part of the Osgood beds with a thickness of 2 feet 2 inches		6	8	5

No.	Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
6. *Dayton limestone.*—Massive zone at top of Dayton limestone with a thickness of 2 feet 3 inches, which splits into 5 layers and the first three in descending order are from 4 to 5 inches each in thickness, while the fourth from the top is 8 inches and the fifth 4 inches thick. Light-gray with blotches and spots of dark-gray, compact rock with stylolites or hackletooth structure at the bedding planes	2	3	7	11
5. Layer of shaly, greenish limestone		10	5	8
4. Compact layer of light-gray color with some dark-gray blotches containing iron pyrite and calcite	1	0	4	10
3. Shale to shaly limestone parting		2	3	10
2. Dark- to light-gray limestone which splits into several layers	3	2	3	8
1. To water level in old quarry pit		6		6

In the foregoing section, Nos. 7 and 8 correspond to the shale zone (No. 7) of the Ehlers quarry and form the upper member of the Osgood beds. The Laurel limestone comprises Nos. 9 to 16, inclusive, with a total thickness of 7 feet 2 inches. The extreme upper part of this quarry wall shows nearly 3 feet of light-gray fossiliferous rock which is referred to the Springfield dolomite.

Professor Bownocker has recently published a bulletin on the "Building Stones of Ohio" which contains a section of this quarry.[1] In this bulletin the zone called the "West Union limestone" corresponds to the "Mottled zone," No. 17 of the foregoing section, and the upper limestone of the "Osgood beds" is what the writer is correlating with the Laurel limestone of Indiana, and includes Nos. 9 to 16, inclusive, of the foregoing section. The blue shales overlying the Dayton limestone of Professor Bownocker's section correspond to Nos. 7 and 8 of the writer's section, the top of which he regards as corresponding to the top of the Osgood beds of Indiana.

GENERAL SECTION ALONG LUDLOW CREEK

A general section of the formations exposed at Ludlow Falls and in the series of quarries on the northern bank of the stream has been

[1] *Geological Survey of Ohio, 4th Ser., Bull. 18* (1915), p. 37.

compiled from the separate sections described above, which shows the formations from the upper part of the Richmond in the Ordovician system to the lower part of the Springfield dolomite in the Silurian system. Some of the zones or formations vary in thickness in different outcrops, in which case the variation in thickness has been given. This necessarily causes a variation in the entries in the column of total thickness.

GENERAL SECTION ALONG LUDLOW CREEK

Total Thickness	Thickness of Zone or Formation	Names of Series and Formations
		Niagaran Series
$57\frac{3}{4}'$ to $61'$	.....	
	$2\frac{1}{2}\frac{1}{2}'$	*Springfield dolomite* (only lower part shown)
$54\frac{5}{8}'$ to $58\frac{1}{2}\frac{1}{8}'$	.....	
	$5\frac{1}{2}'$	Mottled zone
$49\frac{1}{3}'$ to $52\frac{7}{1}\frac{7}{2}'$		
	$7\frac{1}{8}'$	*Laurel limestone*
$42\frac{1}{6}'$ to $45\frac{5}{1}\frac{5}{2}'$		Top of *Osgood beds*
	$1\frac{1}{1}\frac{1}{2}'$ to $3\frac{1}{6}'$	Shale zone
$40\frac{1}{4}'$ to $42\frac{1}{4}'$	.....	*Dayton limestone*
	$11\frac{1}{1}\frac{1}{2}'$	Base of *Osgood beds*
$29\frac{1}{8}'$ to $31\frac{1}{6}'$		
		Oswegan Series
	$26\frac{1}{2}'$ to $28\frac{1}{2}'$	*Brassfield limestone*
$2\frac{2}{3}'$	.....	
		Cincinnatian Series
	$2\frac{2}{3}'$	*Belfast bed* at top of *Richmond formation*
$0'$	.....	

A mere outline of the classification of the formations of the Niagaran series along the Ohio-Indiana state line was published by the writer on April 20, 1915,[1] and the Brassfield limestone was given in the Oswegan series.[2]

Correlation of the Brassfield limestone.—The limestone in the foregoing sections, which is called the Brassfield, is the one which in Ohio has generally been called the Clinton and correlated with the well-known New York formation of that name, which forms the

[1] *Outlines of Field Trips in Geology for Central Ohio*, The College Book Store, Columbus, Ohio, p. 18.

[2] *Ibid.*

basal part of the Niagaran series of that state. As early as 1896 Dr. Foerste stated that—

> The identity between the Clinton faunae of the two states [Ohio and New York] on closer examination is not found to be so close as at first supposed. Whether this is due to geographical causes, the Clinton of New York being more litoral, or whether it is due to moderate differences of horizon, can not be told until the Clinton of New York is much more closely studied. Although I have been accustomed to call the Ohio formation the Clinton, yet I should be willing to recognize the fact that the identity is not very marked, by giving it a name of its own, for instance, the *Montgomery formation*, on account of its typical development in Montgomery County, in Ohio.[1]

In 1906 Dr. Foerste proposed the name Brassfield formation for this limestone from outcrops "along the Louisville and Atlantic Railroad, between Brassfield and Panola, in Madison County," Kentucky.[2] It was stated that "for the . . . . limestone section at the base of the Niagaran division of the Silurian, hitherto identified with the Clinton of New York, the name Brassfield limestone is proposed."[3]

After listing the fauna of the Brassfield limestone in Kentucky, Ohio, and Indiana, and noting the absence in it of certain characteristic Brachiopods of the New York Clinton, Dr. Foerste wrote as follows:

> The identification of the Brassfield limestone of Kentucky, and of its northern extension in Ohio and Indiana, in former years, with the Clinton limestone of New York, rests rather upon a somewhat similar facies of the two faunas, and upon the general absence of the more typical species of the Rochester shale fauna of New York in these limestones at the base of the Silurian in Ohio, Indiana, and Kentucky, than upon the presence of any considerable number of species common to both areas. On closer inspection, the fauna of the Brassfield limestone of Ohio, Indiana, and Kentucky appears to differ sufficiently from the fauna of the Clinton limestone of New York to warrant the assumption of the presence of some sort of barrier between these two areas.[4]

Dr. Foerste has also stated in a later publication that "the Brassfield limestone is the southern continuation of the strata which were identified in Ohio, by Professor Orton, as Clinton."[5]

[1] *Journal of the Cincinnati Society of Natural History*, XVIII, 189.

[2] *Kentucky Geological Survey, Bull.* 7, p. 27. [3] *Ibid.*, p. 18. [4] *Ibid.*, p. 35.

[5] *Journal of the Cincinnati Society of Natural History*, XXI (September, 1909), 1.

At the 1912 meeting of the Geological Society of America, Professor Charles Schuchert proposed the Cataract formation: "a new formation at the base of the Siluric in Ontario and New York," from a locality called the Cataract in the Credit River region of Ontario, 48 miles northwest of Toronto.[1] In August of the same year Professor William A. Parks in describing "The Palaeozoic section at Hamilton, Ontario," stated that "a new formation—the Cataract— . . . . represents an invasion from the north and west at the commencement of Silurian time. The upper limestones and shales of this formation are highly fossiliferous and present a fauna comparable with that of the Brassfield formation of Ohio and Kentucky."[2]

Dr. Merton Y. Williams described a series of sections in the Niagara escarpment of Ontario in a paper before the Geological Society of America in December, 1913, in which he reported that "the Medina sandstones of Niagara gorge (125 feet thick) are represented farther north by dolomite and shales (Cataract formation)."[3]

An article by Dr. Kindle on "What Does the Medina Sandstone of the Niagara Section Include?" contains the following sentence: "The examination by the writer of a number of sections holding this fauna [Cataract] in connection with a review of the Niagara section has convinced him that all of the terranes associated with the Cataract fauna are represented in the Medina of the Niagara section."[4]

In a later and exhaustive paper on the "Medina and Cataract Formations of the Siluric of New York and Ontario," Professor Schuchert shows the close relationship of the Brassfield fauna to that of the Cataract formation of Ontario and also "that the Cataract is a close correlate with the Medina" formation of New York.[5] In another place is the statement that "in other words, the

[1] *Bulletin of the Geological Society of America*, XXIV (March, 1913), 107.

[2] *Guide Book No. 4* (Twelfth International Congress of Geologists), "Excursions in Southwestern Ontario," B_3, p. 128.

[3] *Bulletin of the Geological Society of America*, XXV (March, 1914), 40.

[4] *Science*, N.S., XXXIX (June 19, 1914), 918.

[5] *Bulletin of the Geological Society of America*, XXV, (September, 1914) 291.

typical Medina formation shades through lateral alteration into the typical Cataract."[1]

This apparently agrees with the idea expressed by Professor R. Zuber, of the University of Lemberg, on the escarpment at Hamilton, Ontario, in August, 1913, when he said that the Medina and Cataract appeared to him to be different facies of the same formation. Concerning the relation to the Brassfield, Professor Schuchert wrote:

> The Cataract may also be compared with the Brassfield formation of Ohio and Indiana, as the two are clearly related, and also both are of a limestone facies. The former has 76 species and the latter 140. Between the two there are 24 forms in common. . . . . When the two biotas are finally carefully compared with each other, there will undoubtedly be added more significant forms strengthening the view that the Cataract and Brassfield are fairly close correlates in time. However, as these two faunas are not of the same epicontinental basin, one cannot expect a large percentage of the forms to be common to both; the Brassfield element came in from the Gulf of Mexico region, while the Cataract migrated into Ontario through the Gulf of St. Lawrence embayment across the Province of Quebec or came in from the Arctic.[2]

A little later Dr. M. Y. Williams, in his article on the "Stratigraphy of the Niagara Escarpment of Southwestern Ontario," has stated that "Medina is used in the sense in which Grabau has redefined the term, that is, to include the beds above the Queenstown shale and below the Clinton formation. It is extended, however, laterally to include the Cataract formation as defined by Schuchert."[3]

The Medina sandstone underlies the Clinton beds of New York and is not included in the Niagaran series, but is the upper formation of the Oswegan series as classified by the New York Geological Survey. Therefore, if the correlation reviewed above be accepted, then the Brassfield limestone (formerly called Clinton) of Kentucky, Ohio, and Indiana is to be transferred from the Niagaran to the Oswegan series of the Silurian system.

Furthermore, Professor T. E. Savage believes that in the Mississippi Valley the Sexton Creek limestone "represents about the

[1] *Ibid.*, p. 294. [2] *Ibid.*, p. 291.

[3] *Summary Report of the Geological Survey* [Canada] *for the Calendar Year 1913* (1914), p. 182.

same general period of deposition as the Brassfield limestone."[1] The Sexton Creek limestone is the upper formation of the Alexandrian series, named and described by Professor Savage,[2] a series that in Illinois and Missouri contains all the formations between the Richmond-Maquoketa formation, at the top of the Cincinnatian series, and the base of the Niagaran series.

Since the above was written, advance pages of a work on *Historical Geology* by Professor Schuchert have been received in which the following correlation appears:

Lower Silurian or Oswegan	Medina, Cataract, and Brassfield formations. Becsie limestone.[3]

OTHER SECTIONS OF WESTERN OHIO

Sections farther up the Stillwater River toward Covington show the middle and upper parts of the section exposed along Ludlow Creek, while those in Covington carry the general section still higher. Sections farther west, near Lewisburg and New Paris, agree essentially with those of the Stillwater Valley.

Sections in and near Covington.—About two miles south of Covington is the Jackson Stone Co. quarry, near the Stillwater River, on the Charles H. Jackson farm. It is easily reached by the Piqua, Covington, and Dayton trolley line, leaving the car at stop 45, which has the name of Sugar Grove. The section given below is of the eastern wall of the quarry, the top of it near the engine house, a short distance southwest of the crusher.

SECTION OF THE JACKSON STONE CO. QUARRY

No.		Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
22.	*Cedarville dolomite.*—Buff, mostly porous, crystalline dolomite, with *Pentamerus oblongus* Sowerby common all through the outcrop. Zone at base with large number of specimens of *Pentamerus oblongus* Sowerby as well as *Favosites niagarensis* Hall.....	3	8	109	9

[1] *Illinois State Geological Survey, Bull. 23* (1913), p. 33.

[2] *American Journal of Science*, 4th Ser., XXV (1908), 434, 443; *Illinois State Geological Survey, Bull. 23*, pp. 14, 15.

[3] *A Text-book of Geology*, Part II, *Historical Geology* (1915), p. 661.

No.		Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
21.	*Springfield dolomite.*—Buff-colored, rather thin, layers of even-bedded dolomite. The layers vary in thickness from 2 to 8 inches and the majority of the layers are probably from 4 to 6 inches thick. No one of the exposed layers is blue. Fossils, as *Pentamerus oblongus* Sowerby, and corals are common and certain layers contain numerous specimens of *Pentamerus oblongus*. This zone, with its thin even beds of buff color, has clearly the lithologic appearance of the Springfield dolomite	10	6	106	1
20.	Bluish-gray, weathering to a buff color, rather compact, slightly porous, dolomite which generally splits into two layers	1	½	95	7
19.	Bluish-gray, somewhat mottled, layer which contains but few fossils		10½	94	6½
18.	Bluish-gray layer, fairly compact, in part subcrystalline, with some small holes and containing large numbers of *Pentamerus oblongus* Sowerby. On account of the large number of fossils this zone may be called a *Pentamerus* layer and clearly belongs in the Springfield dolomite		10	93	8
17.	*Mottled zone.*—Massive layer of bluish-gray dolomite marked with large, irregular-shaped spots of light-gray color, so that the entire surface has a coarsely mottled color. It has a porous structure with medium-sized cavities. It contains some fossils, as, for example, cup corals and crinoids, with an occasional specimen of *Pentamerus*. At the base is a stylolites parting	7	2	92	10
16.	*Laurel limestone.*—Lithologically like lower layers, thickness varying from 9 to 10 inches, more porous in upper 4 inches, with small and larger holes. Some fossils, as a cup coral and *Pentamerus?*		9½±	85	8
15.	Bluish-gray, somewhat porous, limestone. A cup coral was noted		10	84	10½
14.	Layer of light-gray mottled with dark-gray, fairly compact, limestone, varying in thickness from 12 to 13 inches	1	½±	84	½

No.	Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
13. Light-gray limestone in 4 layers, with shaly partings, varying in thickness from 19 to 21 inches. Lithologically similar to subjacent layers	1	8 ±	83	0
12. Light-gray, with dark-gray spots and blotches, compact limestone, which is harder than lower layers and varying in thickness from 12½ to 13 inches	1	¾ ±	81	3¾
11. Gray, weathering to a brownish color, gritty shale, about 1 inch thick		1 ±	80	3
10. Layer lithologically about the same as the subjacent one		5	80	2
9. Light to slightly brownish-gray with dark-gray blotches and spots of hard limestone, varying in thickness from 14 to 16 inches. Mr. Harry H. Brandon of the Jackson Stone Co. stated that the Laurel limestone worked in this quarry, Nos. 9 to 16, inclusive, with a thickness of 7 feet 1 inch, is a superior rock for macadamizing roads and in respect to its binding quality is one of the best in the state	1	3 ±	79	9
8. Light-gray limestone blotched with dark-gray spots and streaks from pyrite. Calcite crystals are also present. It is a hard layer which forms the present floor of the quarry (August, 1914), and its upper surface is undulating, forming sort of dome-shaped elevations		5	78	6
7. Gray, gritty shale and perhaps rather calcareous		3 ±	78	1
6. Light-gray limestone blotched with spots and streaks of darker-gray color, which are due to pyrite in small grains that has discolored the rock; when weathered it changes to a brown or rather rusty color. The zone varies in thickness from 16 to 17 inches and is the base of the Laurel limestone, which in this quarry has a thickness of 9 feet 1 inch	1	4½	77	10
5. *Osgood beds.*—Dark-gray shale, very gritty to the teeth, which is exposed in upper part of pit in floor of quarry. The measurements and characters of the zones below the floor of the				

No.		Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
	quarry to and including No. 5 were obtained from the outcrops in the upper part of the pit in the floor of the quarry	1	8	76	5½
4.	*Dayton limestone.*—This zone was not exposed at the time the quarry was studied on August 29, 1914. Mr. Brandon, however, stated that it is 12 feet in the pit from the bottom of the quarry to the white "Clinton" limestone. If the statement that it is 12 feet from the floor of the quarry down to the top of the white "Clinton" is correct, then the Dayton limestone has a thickness of about 8 feet 3½ inches. Mr. Brandon described it as a hard, blue stone	8	3½	74	9½
3.	*Brassfield limestone.*—Mr. Brandon stated that in the well drilled at the engine house in this quarry the white "Clinton" is between 18 and 20 feet thick	19	0	66	6
2.	*Richmond formation.*—Mr. Brandon stated that below the white "Clinton" the well passed through 45½± feet of blue stone, and the base of this zone he reported as 110 feet below the mouth of the well in the engine house	45	6	47	6
1.	The well penetrated 2 feet of rock, which is described by Mr. Brandon as reddish "granite." Bottom of well	2	0	2	0

A halftone of the eastern wall of this quarry, the one described in the foregoing section, is given in Fig. 1. The lower part of the wall shows the Laurel limestone. Mr. Cottingham's foot is on top of the "mottled zone," his hand marks the base of the 10½-foot zone of Springfield dolomite, while the extreme top of the bank below the building is the basal part of the Cedarville dolomite.

The foregoing record is an important one in the series of sections in this part of the state, since there is a continuous exposure from the Osgood shale up and into the lower part of the Cedarville dolomite. The Laurel limestone is well shown and has a thickness

of about $9\frac{1}{6}$ feet, which is 2 feet more than its thickness in the Maxwell quarry of Ludlow Creek. Samples of the Laurel limestone from this quarry were analyzed by Professor D. J. Demorest with the following result:

Silicious Residue	Fe_2O_3 and Al_2O_3	$CaCO_3$	$MgCO_3$
14.35	1.40	52.68	29.53

The "mottled zone" is also thicker, since in this quarry it is 7 feet 2 inches, while it is only 5 feet 6 inches in the Maxwell quarry. The Springfield has a thickness of 13 feet 3 inches, overlying which is the lower 3 feet 8 inches of the Cedarville dolomite. The northern wall of this quarry extends higher stratigraphically than the eastern wall below the crusher, and on this wall the "mottled zone" is 6 feet 10 inches thick, above which is 13 feet of Springfield dolomite, capped by 9 feet 5 inches of Cedarville dolomite. At the northern end of the eastern wall almost 10 feet of the Cedarville dolomite is shown.

An illustration of this quarry has been published[1] under which appear the names "West Union, Springfield, and Cedarville limestones." The West Union probably refers to what is listed as the "mottled layer" in the foregoing section.

The recent bulletin by Professor Bownocker contains a section of this quarry[2] in which the "West Union limestone" corresponds to the "mottled zone," No. 17 of the foregoing section, and the upper limestone of the "Osgood beds" corresponds to what the writer correlates with the Laurel limestone of Indiana, Nos. 6–16 of his section. The 2 feet of "dark-blue shale" of Professor Bownocker's section corresponds to No. 5 of the writer's section, and he considers the top of this shale as corresponding to the top of the Osgood beds in Indiana.

[1] *Eighth Annual Report of the State Highway Department of Ohio* (1913), Fig. 9, p. 257. The geological part of the report is probably to be credited to Mr. W. C. Morse, judging from the statement on p. 17.

[2] *Geological Survey of Ohio, 4th Ser., Bull. 18* (1915), p. 36, and Pl. III opposite this page apparently gives a view of this quarry or one in its vicinity.

The upper Niagaran dolomites were formerly extensively quarried in Covington, but in recent years they have not been worked to any extent. Just south of the town is the J. W. Ruhl

FIG. 1.—Eastern wall of the Jackson Stone Co. quarry, two miles south of Covington, Ohio. The lower part is the Laurel limestone. Mr. Cottingham's foot is on top of the "mottled zone," above which is all of the Springfield dolomite, while the top of the wall is the base of the Cedarville dolomite.

quarry, the long wall of which is visible from the traction cars to the west of the track. The following section of the eastern wall, near its upper end and a short distance south of Bridge Street, was made:

SECTION OF THE J. W. RUHL QUARRY AT COVINGTON

No.		Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
11.	*Cedarville dolomite.*—Fairly massive, gray to buff, porous dolomite, with the characteristic lithologic appearance of the Cedarville. Certain layers contain abundant impressions of crinoid segments and parts of stems with an occasional cup coral. Rather infrequently more or less of the calcareous material of a crinoid stem is preserved. In the weathered wall are rather large holes in addition to the smaller ones which give it the porous structure. Near the base, *Spirifer* and other Brachiopod shells were noticed in association with crinoids. The upper 11 feet of this part of the quarry wall belong in the Cedarville, but on a wall farther south some 15 feet of Cedarville are shown...	11	0	26	5
10.	*Springfield dolomite.*—When weathered, buff, compact rock containing small holes, due to solution of crinoid fragments. Layers vary from 2 to 6½ inches in thickness; but the majority are 3, 4, or 5 inches thick. All of the zone is somewhat porous.....	2	6	15	5
9.	Chert zone containing 4 layers of chert. The rock is harder than in the zone above, denser, not so porous, and of slightly greenish-gray color. *Pentamerus oblongus* Sowerby occurs in the second chert above the base as well as in the lowest one.....	2	10	12	11
8.	Ten-inch layer in which *Pentamerus oblongus* Sowerby is common.....		10	10	1
7.	Compact, hard rock, somewhat rough on the broken surface. Color gray; but of different shades, so that it is not uniform.....	1	8	9	3
6.	Hard, compact, light-gray rock in which holes are infrequent. Stylolites are frequent in the bedding planes of this part of the quarry wall	1	1	7	7
5.	Lithology of layer similar to overlying one...	1	1	6	6
4.	Similar, but with a more conspicuous bedding plane at the base.....	1	3	5	5
3.	Massive gray layer near bottom of quarry, which has pretty compact structure, but is not so hard as the three layers which immediately				

No.		Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
	overlie it. It contains some calcite crystals and a Brachiopod shell similar to a small *Pentamerus*	1	10	4	2
2.	Layer similar in lithologic characters to the superjacent one		6½	2	4
1.	*Mottled zone.*—Massive layer of drab color, mottled with light-gray spots and blotches. Compact rock and harder than layers above. This was the lowest exposed layer near the northern end at the time the quarry was studied in July, 1914	1	9	1	9

The Springfield dolomite in this quarry is believed to comprise the zones numbered 2 to 10, inclusive, which have a total thickness of 13 feet 7½ inches. The same formation in the Jackson quarry is 13 feet 3 inches thick, which shows a close agreement in these two sections, since there is a difference of but 4½ inches in the thickness of the Springfield formation in the two quarries.

Section near Lewisburg.—About 20 miles southwest of Covington is the large quarry of the Lewisburg Stone Co., which is rather more than a mile northwest of the station at Lewisburg, Preble County, and located on the southern bank of Twin Creek. This quarry and the bank of Twin Creek below the crusher furnish an important section, since almost the complete series of rocks from the upper part of the Brassfield limestone into the lower part of the Cedarville dolomite are admirably shown. The western wall of the quarry extends higher stratigraphically than the southern wall, but with the exception of the extreme top of the section it was the southern wall of the quarry toward the western end that was measured.

SECTION AT THE LEWISBURG STONE CO. QUARRY

No.		Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
20.	*Cedarville dolomite.*—Light-gray, weathering to a dark-gray, porous rock with the lithologic appearance of typical Cedarville. At the time the quarry was studied, on account of the shattered condition of the wall, due to extensive blasting, it was difficult to decide where the line				

No.		Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
	between the Cedarville and Springfield dolomites ought to be drawn. This zone appears certainly to belong in the Cedarville and possibly it may be the base	4	7	53	11
19.	Zone on southern wall with abundant specimens of *Pentamerus oblongus* Sowerby; but on the western wall the fossils are not common		3	49	4
18.	Rather compact, light-gray rock containing abundant crinoid stems and an occasional specimen of *Pentamerus oblongus* Sowerby. Some chert in more or less definite layers. On the western wall a zone corresponding to this and including the superjacent 3 inches is rather clearly marked. It contains chert in layers and has a thickness of 4 feet 10 inches	3	3	49	1
17.	"First cap rock" of the quarrymen. Gray and very porous rock, the cavities to a large extent apparently due to the solution of fossils. This zone has the lithologic appearance of the Cedarville dolomite, and it is not improbable that it belongs in that formation. According to Mr. E. T. Paul, manager of the Lewisburg Stone Co., the thickness of this zone is variable and "runs from 2 feet up to about 5 feet; the average, however, being about 3½ feet."	3	6	45	10
		Feet	Inches		
16.	*Springfield dolomite.*—The four following layers are composed of light-gray to perhaps buff-colored rock, which has rather compact texture. It is now used for cut stone	2 1 1	2 4 8 5	42	4
		5	7		
15.	Buff, massive zone which splits into 2 or 3 layers and contains *Calymmene niagarensis* Hall. This zone and the superjacent 4 layers are called "buff rock" by the quarrymen	3	0	36	9
14.	*Mottled zone.*—"Second cap rock" of the quarrymen. Light-gray, porous rock with dark-gray spots and blotches. It contains crinoid segments and fragments of other fossils. The lithologic appearance of the zone is very similar to that of the mottled zone in the Jackson and Maxwell quarries and the interval between the				

No.		Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
	base of the mottled zone and the top of the Osgood shale is about the same in all three sections	4	1	33	9
13.	*Laurel limestone.*—The following courses all have a bluish-gray color when seen on fresh surface:				
	Light-gray, compact course (Inches 6–7)				
	Light-gray, compact course (Inches 4–5)				
	Light-gray course, the upper part blotched with dark-gray spots, but not many in lower part (Inches 8)				
	Shaly limestone parting (Inches ¼–1)				
	Light-gray, compact layer (Inches 8)				
	Light-gray course, with dark-gray spots and bands which tend to split into 2 layers (Inches 8)	6±	0	29	8
	Light-gray layer (Inches 9–9½)				
	Very mottled light- and dark-gray, thin layer (Inches 3½)				
	Light-gray layer (Inches 10)				
	Similar to above layer with a broken parting at base (Inches 8)				
	Bluish-gray layer with dark-gray streaks and spots (Inches 6)				
	The total thickness of the above layers varies from 5 feet 10¾ inches to 6 feet 2 inches.				
12.	The three following layers are of light-gray color with dark-gray spots, blotches, and streaks and have about the same lithologic appearance:				
	First layer (Feet 1 Inches 3)				
	Second layer (Inches 10)				
	Compact, massive layer containing calcite crystals (Feet 2 Inches 1)	4	2	23	8
11.	*Osgood beds.*—Bluish-gray, soft shale which forms the floor of the quarry. Six inches or more are shown in the quarry. Mr. Robert Mollett, foreman of the quarry, stated that at the time of the March flood of 1913 the shale was shown by the side of the railroad track				

No.		Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
	below the crusher and varies in thickness from 2 feet 6 inches to 3 feet	2	9 ±	19	6
	Dayton limestone.—Mr. Mollett stated that the upper surface is somewhat uneven and that the limestone extends about 1 foot higher than the top of the exposed ledge on the south bank of Twin Creek below the Lewisburg Stone Co. crusher.				
10.	Upper foot, according to Mr. Mollett, not exposed	1 ±	0	16	9
9.	Light-gray layer, very rusty colored from weathered iron pyrite. Varies in thickness from 1 to 2½ inches		1¾ ±	15	9+
8.	Mostly light-gray, thin-bedded to shaly, limestone	1	0	15	7½
7.	Thin layer of more or less crystalline structure, which contains fossils		2 ±	14	7½
6.	Bluish-gray, thin-bedded layers, weathering to a very light-gray or whitish color. Rarely thin, somewhat irregular, finely crystalline layers in which is an occasional fossil	2	4	14	5½
5.	This zone will split into 3 layers. The upper one contains much pyrite and has weathered in spots to a very rusty color. The middle and lower parts of light-gray color with spots and irregular layers of dark-gray color from iron pyrite		10	12	1½
4.	Light-gray to bluish-gray, rather thin-bedded layers on bank of creek, with slightly glistening surface. Upper part of zone contains imperfect Brachiopods	2	4	11	3½
3.	Light-gray, compact layer which is harder than rock above. Base at creek level on September 5, 1914		7	8	11½
2.	Two thin layers of compact, bluish-gray rock, the upper one 2 inches and the lower one 2½ inches thick		4½	8	4½
1.	*Brassfield limestone.*—The upper surface rough. Mottled pink and gray crystalline limestone in bed of creek, just below the bank of Dayton limestone. In the bed of the creek 13 inches				

No.	Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
of Brassfield limestone was measured; but it extends on down the creek and a quarryman stated that about 8 feet is shown along the creek	8±	0	8	0

A view of the southern wall of the Lewisburg Stone Co. quarry is shown in Fig. 2. The lower part of the wall is the Laurel even-bedded limestone, the top of which Mr. Cottingham is indicating by the hammer, above which is the conspicuous "mottled zone," and above this zone is the Springfield dolomite.

In the foregoing section the Laurel limestone is called the "blue building stone" by the quarrymen and comprises Zones 12 and 13 with a thickness of about 10 feet 2 inches. A section at a different part of the southern quarry wall gave a thickness of 9 feet 10 inches. It is well shown in the picture of the southern wall of this quarry (Fig. 2) where Mr. Cottingham is marking its top with the hammer. Samples of the Laurel limestone from the southern wall of this quarry were analyzed by Professor Demorest with the following result:

Silicious Residue	Fe_2O_3 and Al_2O_3	$CaCO_3$	$MgCO_3$
8.85	1.20	56.00	32.21

The massive "mottled zone," with a thickness of 4 feet 1 inch, immediately above the Laurel limestone, is also well shown in Fig. 2. Samples from this zone in the southern wall of the quarry were also analyzed by Professor Demorest with the following result:

Silicious Residue	Fe_2O_3 and Al_2O_3	$CaCO_3$	$MgCO_3$
2.54	0.75	54.12	42.13
2.55	0.80	54.12	42.31

The following analysis by Professor Demorest of samples of the West Union limestone from Sproull Ravine, about $1\frac{1}{2}$ miles

northeast of Duncanville and $7\frac{1}{2}$ miles northeast of West Union, Adams County, is given for comparison with that of the "mottled zone:"

SiO_2	Fe_2O_3 and Al_2O_3	$CaCO_3$	$MgCO_3$
20.24	4.05	44.67	29.14

It will be seen from these analyses that the West Union is a much more silicious rock than the "mottled zone" and that the latter is a dolomite. It is to be noted that the chemical composition and lithologic character of the "mottled zone" differ considerably from those of the West Union limestone in its typical region.

The rock between the first and second cap rocks of the quarrymen is called by them the "buff building stone" and corresponds to Zones 15 and 16 of the last-given section, all of which evidently belongs in the Springfield dolomite.

All the rock above the shale zone (No. 11) of the Osgood beds is quarried and crushed for concrete and road material. The fine rock, which the men call "sand," binds well on the roads, and it was stated that the entire product of the quarry for 1914 was used on the Ohio roads by the State Highway Commissioner.

Dr. Foerste some years ago published a brief description of the Weaver quarries, located on the northern side of Twin Creek, opposite the eastern part of the Lewisburg Stone Co. quarry.[1] Recently Professor Bownocker has published a section of the Lewisburg quarry in which the upper limestone of the Osgood beds with a thickness of 9 feet 11 inches corresponds to the Laurel limestone of the last-given section.[2] The 3 feet of blue clay beneath is the Osgood shale and the subjacent 10 feet of "blue-gray limestone" the Dayton. The "West Union limestone," $4\frac{1}{2}$ feet thick,[3] corresponds to the "mottled zone" of the last-given section, overlying which is the Springfield with a thickness of 8 feet and then the Cedarville which forms the highest part of the quarry. Apparently the line of division between the Springfield and Cedarville dolomites

[1] *Journal of the Cincinnati Society of Natural History*, XVIII (1896), 183, 184.

[2] *Geological Survey of Ohio, 4th Ser., Bull. 18* (1915), p. 40.

[3] *Ibid.*, p. 39.

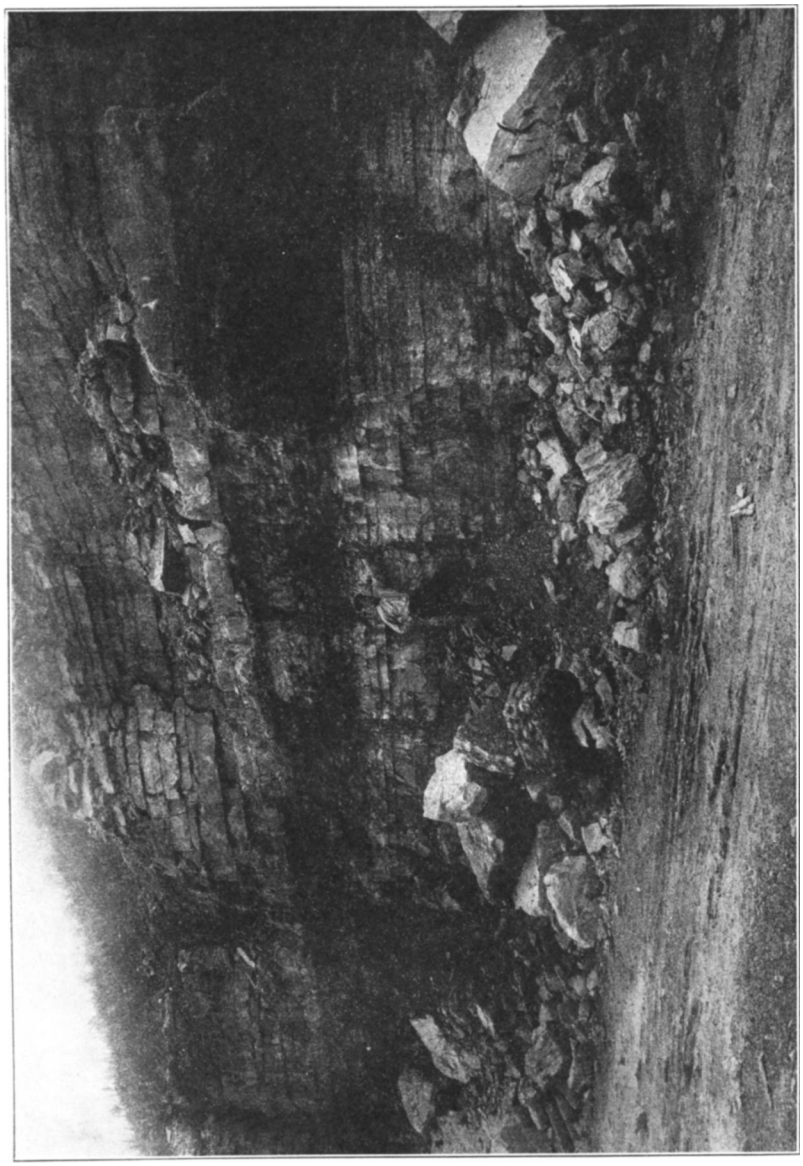

FIG. 2.—Southern wall of the Lewisburg Stone Co. quarry, one mile northwest of Lewisburg, Ohio. The lower part is the Laurel limestone, the top of which is marked by the hammer. Above the Laurel limestone is the conspicuous "mottled zone," overlying which is the Springfield dolomite.

is drawn at the same horizon as the top of Zone 16 in the writer's section, which gives a thickness of 8 feet 7 inches for the Springfield or 8 feet as measured by Professor Bownocker.

SECTION NEAR LAUREL, INDIANA

In the foregoing sections the correlation of the terranes referred to the Osgood beds and the Laurel limestone, both of which were named by Dr. Foerste,[1] was decided upon after visiting Laurel, Indiana, and studying some of his sections in that typical region. A section at one of these localities, in a somewhat condensed form, is given below. The section is on the bank of a stream at a locality known as Derbyshire Falls, on the C. J. Valkenburg farm, nearly 3 miles southwest of Laurel and some 47 miles southwest of the Lewisburg Stone Co. quarry. A section of the Laurel limestone, Osgood beds, and Clinton limestone measured at this locality and the Lower Derbyshire Falls was published by Dr. Foerste in 1898.[2] The measurements in the following section are those of the writer and his assistant, Mr. Kenneth Cottingham; but the classification is in accordance with that of Dr. Foerste, except where differences are noted:

DERBYSHIRE FALLS SECTION

No.	Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
18. *Laurel limestone.*—This limestone is shown in the old quarry just across the quarry road to the south of Derbyshire Falls and this zone extends to the top of the quarry wall. It is light gray, as weathered, rather thin-bedded, the layers varying from 2 to 8 inches in thickness. There are also at least 3 chert layers ranging from 1 to 3 inches in thickness.....	4	7	52	0

[1] Osgood beds: *Indiana Department of Geology and Natural Resources, 21st Annual Report* (1897), pp. 217, 227–29.

Laurel limestone: *Journal of the Cincinnati Society of Natural History*, XVIII (February, 1896), pp. 190, 191, and *Indiana Department of Geology and Natural Resources, 21st Annual Report* (1897), pp. 217, 230, 231.

[2] *Indiana Department of Geology and Natural Resources, 22d Annual Report* (1898), pp. 244, 245. An illustration of Derbyshire Falls is given on Pl. XVI, which faces p. 244.

No.		Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
17.	Thicker layers of compact limestone, light gray to buff, when weathered, with shaly partings. The majority of the layers are perhaps 3 to 5 inches in thickness; but there are thicker ones which apparently range from 8 to 14 inches. No chert was noticed in this zone.....	5	3	47	5
16.	*?Top of Osgood beds.*—Buff, compact, 8-inch layer at top of ledge on south side of falls, which is apparently the one across the quarry road in the base of the old quarry at the spring. The top of this layer is apparently the horizon where Dr. Foerste has drawn the line of separation between the Osgood beds and Laurel limestone. Lithologic characters, however, in the vicinity of Laurel would apparently favor classing it with the Laurel limestone.....		8	42	2
15.	Blue, argillaceous, soft shale or clay. This is the blue-clay stratum of Dr. Foerste.....	1	6	41	6
14.	Shaly, light-gray limestone.....		4	40	0
13.	Light-gray, compact, even-bedded limestone; some of the bedding planes rather rough. The layers vary in thickness from 5 to 9 inches, and perhaps the majority of them average about 8 inches. This is the Lower Quarry or Osgood rock of Dr. Foerste, and is apparently the continuation of the Dayton limestone in Indiana	6	4	39	8
12.	*Brassfield limestone.*—Light-gray, crystalline limestone. Apparently the upper foot and 3 inches of this zone was regarded by Dr. Foerste as a "doubtful horizon: White Clinton or base of Niagara rock".....	2	3	33	4
11.	Crystalline gray to pinkish limestone. It is very irregularly bedded and contains pyrite, so that it is frequently rusty colored on the weathered surface. Dr. Foerste's section reports "Clinton; 7 feet 6 inches; reddish"....	6	7	31	1
10.	*Richmond formation.*—Light-gray, impure limestone with portions that are darker colored...	1	6	24	6
9.	Gray, impure limestone, the upper layer a foot thick separated by a shaly parting from a lower layer of similar limestone, 1 foot 3 inches thick	2	3	23	0

No.	Thickness Feet	Thickness Inches	Total Thickness Feet	Total Thickness Inches
8. One layer of gray, massive, impure limestone. No fossils seen	4	0	20	9
7. Layer similar to one above	2	2	16	9
6. Massive, light-gray layer with dark-gray spots. No fossils noted	3	0	14	7
5. Shale parting		1	11	7
4. Grayish, somewhat crystalline, limestone which tends to split into thinner layers		9	11	6
3. Bluish shales alternating with gray, fossiliferous limestone	2	3	10	9
2. Grayish, somewhat crystalline, limestone, hard and very fossiliferous	5	4	8	6
1. Grayish to bluish shales which are not very fossiliferous. Foot of falls	3	2	3	2

In the foregoing section Zones 11 and 12, with a thickness of 8 feet 10 inches, have been classed together and considered the western continuation of the Brassfield limestone of Ohio. Zones 13 and 14 of light-gray limestone with a thickness of 6 feet 8 inches are considered the western continuation of the Dayton limestone of Ohio. Dr. Foerste has stated that "in Ohio *Pentamerus oblongus* occurs in the Dayton limestone, equivalent to the base of the Osgood bed."[1] The soft blue shale or clay of Zone 15 is believed to correspond to the blue shale of Zone 11 in the Lewisburg Stone Co. quarry and the shale at the same horizon in the various quarries along the Stillwater River. As stated above in the description of the section, the lithologic break occurs at the top of this shale, which appears to the writer from the sections which he has studied to be the horizon where he would draw the line of division between the Osgood beds and Laurel limestone. If the 8-inch layer of compact, buff limestone (No. 16) immediately above the soft blue shale zone be classed with the Laurel limestone, then $10\frac{1}{2}$ feet of it are shown in the wall of the old quarry on the bank above and south of the falls. It is believed to be the eastern continuation of this limestone which makes Zones 12 and 13 with a thickness of 10 feet 2 inches in the Lewisburg Stone Co. quarry and the

[1] *American Journal of Science, 4th Ser.*, XVIII (1904), 341.

limestone which has been called the Laurel in the sections farther east along the Stillwater River.

Samples of the Laurel limestone were collected at the quarry above Derbyshire Falls and analyzed by Professor Demorest with the following result:

SiO_2	Fe_2O_3 and Al_2O_3	$CaCO_3$	$MgCO_3$
17.84	1.00	47.89	31.54

This analysis shows that the Laurel limestone at Derbyshire Falls is a more silicious one than that at the Lewisburg Stone Co. quarry, which contains but 8.85 of silicious residue. On the other hand, the Lewisburg stone contains a larger percentage of $CaCO_3$, where it amounts to 56 per cent of the rock; the other constituents at the two localities do not differ to any marked degree.